

MODIFIED SEXUAL PHOTOPERIODICITY IN COTTON-TAIL RABBITS¹

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INTRODUCTION

Studies too numerous to cite here show that the sexual cycles of many birds and mammals and of some fish and reptiles can be modified and their breeding seasons changed by manipulating daily cycles of exposure to light. Not all are susceptible in the same way nor to the same degree (Bissonnette, 1936, 1938; Marshall, 1936, 1937).

The development of proper methods of conservation and wild life management require knowledge as to what wild animals have photoperiodic breeding cycles and how they react to management of light-cycles. Breeding seasons of some animals have been prolonged to permit two litters per year in place of one, with better than normal growth of early-induced litters (Bissonnette and Csech, 1937, 1938, 1939).

The cotton-tail or gray rabbit of New England (*Sylvilagus transitionalis* (Bangs)) is shot for sport and food, furnishes food for fur-bearing carnivores, and may injure fruit trees in some places and seasons. It exhibits a limited breeding season with three or four litters, beginning about mid-April. It is, therefore, more polyoestrous than most of the animals so far investigated and intermediate between strictly monoestrous or dioestrous and completely polyoestrous forms. It, therefore, has been tested by "night-lighting" in autumn and winter.

MATERIAL AND METHODS

Three pairs of cotton-tails were placed, each in a wire enclosure raised from the ground, with wooden "den" at one end. In each den a few inches of earth were covered with loose dry grass about two inches deep for bedding. Twenty-five-watt bulbs were so placed as to shine into both den and enclosure and controlled by a time switch so that lights were lit for one hour each night for the first week, beginning on October 10. "Night-lighting" was increased one hour each

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ten days thereafter to eight hours on December 17 and maintained into February, and, in one case, into April. Lights came on each evening at six o'clock. All pens were outside, without heating, except from the bulb, throughout the experiment. Feeding and care were similar for all rabbits at the sanctuary.

Replacements were made without altering schedule when animals killed one another and the exact lighting history of each animal recorded. The gonads of killed animals were secured for histological study. But none were sacrificed expressly for such material, because our experience with raccoons and the behavior of these rabbits suggested that matings would lead to litters out of season. Sex-organs were obtained also from unlighted males on December 8 and January 25 for comparison with those of a male killed by his mate, January 12, after night-lighting eight hours each night from December 20.

OBSERVATIONS AND RESULTS

After varying periods of lighting and after matings, two experimental females killed their original mates by biting them through the back. One male killed his mate by grasping her anal region with his teeth and pulling out her abdominal organs which became useless for study. Replacement of males may account for failure of matings to induce pregnancy in December and again beginning on January 5. Controls also mated somewhat later in December and about January 10, all without pregnancies. Bissonnette's studies on male ferrets indicate that willingness to mate antedates potency and fertility by a considerable time. This was probably true here also.

After matings in January, two experimental females made nests and one lined hers with fur to receive young that failed to come. No control did so then, nor until near littering time in April.

The first "experimental" litter (of two) was born on April 4 and died April 10, from exposure. The nest was not heated and the mother left it for long periods. On May 31 and June 30 she produced second and third litters (of one and six) which survived. The first "control" litter came on April 18 and all six died of exposure. None of the other experimental or control females had litters before June 8, although the above-mentioned control female mated again the day her litter was born and others probably did so too. In that season no controls had litters live through. They normally should have had litters every thirty days after mid-April. It was a poor rabbit-breeding season, for reasons as yet unknown. Experimentally lighted animals succeeded slightly better than controls on normal light.

A male, used for replacement on December 20, lighted eight hours

each night until killed by his mate on January 12, had mated about January 5-7 with her. His testes showed sperms just metamorphosed in small numbers in some tubules but none had yet reached the middle part of the epididymis. The apparent breeding condition of this epididymis, with tall columnar epithelium and well developed ciliary processes, indicates functional activity of the interstitial cells of the testis and accounts for sexual libido and matings.

Much smaller testes from the control of December 8 showed smaller tubules with no stages of germ-cells beyond synizesis. Its epididymis, in a partly activated, partly regressed condition, suggested some activity of interstitial cells, which may account for December and January matings of controls. Its epithelium was short columnar with some ciliary processes, less developed than those of the lighted male.

Testes from the January twenty-fifth control were slightly more advanced in spermatogenesis than those of December 8. Its most advanced stages were synizesis and a few growing primary spermatocytes. No germ-cell debris was found in the middle part of the epididymis which was more regressed than that of December 8. Its lining epithelium was more nearly cuboidal, with no ciliary processes evident.

CONCLUSIONS

Increasing night-lighting induces cotton-tail rabbits to undergo sexual activation in winter. In males, it leads to complete libido and spermatogenesis in twenty-three days at January 12, on eight hours of added light from December 20. It would probably induce complete breeding effectiveness in little longer time. In females, it induces repeated receptivity followed by nest-making and even lining of nests with fur.

December and January matings do not alone indicate increased sexual activation, for controls on normal light reacted similarly. Killing of mates is not attributable to added light; but rather it was permitted by the close confinement's preventing escape from an aggressor. Making and lining of nests in January, not done by controls at that time, signify activation above the normal for that time, and suggest pseudo-pregnancy after winter copulations.

Even if litters can be born under the conditions of temperature prevailing in these experiments in winter, they cannot be raised by their mothers, even in their fur-lined nests. The mothers do not keep the nests warm, as do raccoons, but leave them closed for long periods, returning only at intervals to suckle the young, born naked and defenseless against cold. It is suggested, however, that, with warmed nesting places, the long absences of the mother may not permit the young to die nor prevent the raising of litters in winter. In addition, by arranging run-

ways so that males and females can have separate dens and can be separated after matings by a wire screen which permits them to remain acquainted without being able to kill each other, the same pairs may be kept on the lighting schedule and make winter breeding successful. Further experiments along these lines seem to be indicated.

SUMMARY

1. Three pairs of cotton-tail rabbits were confined in dens and runways and subjected to increased lighting at night from October 10 onward. Controls were not lighted but fed similarly.
2. The original objective, induction of winter litters, was not attained because, after varying times of lighting, one member of the pair killed the other and replacements were made on schedule.
3. Sex organs of males were modified to complete sperm formation in twenty-three days in December and January and mating libido reached, accompanied by breeding conditions of the epididymis. Controls showed mating libido but no spermatogenesis nor epididymal activation.
4. Lighted females mated and made nests; and one lined its nest with fur. Controls mated but made no nests. No pregnancies resulted with any female until April.
5. The induced changes indicate that these rabbits can be brought into breeding condition in winter by increased lighting, but modification of the method used and the provision of warmed nest-boxes are necessary for successful winter breeding and rearing of these animals.

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